born infant, with the usual periods of activity, asleep, and awake, is estimated to be approximately 62 calories per kilogram of body-weight per 24 hours. This takes no account of the requirement for growth, which may be neglected in considering the energy requirement for the first week of life. The results of the research give opportunity for suggestions as to supplemental feeding and methods of conserving energy.

A detailed report of the investigation, together with a complete translation of the interesting article on the respiratory exchange of infants, published by Hasselbalch in 1904, is given in Publication No. 233 of the Carnegie Institution of Washington.

A COMPARISON OF METHODS FOR DETERMINING THE RESPIRATORY EXCHANGE OF MAN

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The principal methods of determining the respiratory exchange of man in short periods require the use either of a chamber in which the subject is confined or breathing appliances which are attached to the nose or the mouth or, as in the case of a mask, to the face. Apparatus with breathing appliances are of two classes. In one the subject breathes into and out of a closed current of air driven by a positive blower, the products of respiration being absorbed and oxygen being admitted. In the other type of apparatus valves are used to separate the currents of inspired and expired air and the latter is either measured by a meter or collected in a bag or a spirometer, a sample being taken and analyzed by means of a suitable gas-analysis apparatus.

Thus far no adequate comparison of these different types of apparatus has been made, the only attempt at such comparison being the compilation of results obtained with various respiration apparatus to show that these apparatus measured accurately the respiratory exchange. It therefore seemed desirable to compare the several types of apparatus for determining the respiratory exchange, with men as subjects and with as nearly identical conditions as possible.

The apparatus employed in this investigation were the following: Bed respiration calorimeter (chamber type with closed circuit); two forms of the Benedict universal respiration apparatus, i.e., tension-equalizer unit and spirometer unit (apparatus with breathing appliance, closed circuit type); Zuntz-Geppert apparatus (valves with meter and gas-analysis apparatus); Tissot apparatus (valves with an automatically counterpoised spirometer); Douglas apparatus (valves with rubber-lined cloth

Results of comparisons of the respiratory exchange obtained with different apparatus.

APPARATUS COMPARED	NUMBER OF		ARITHMETICAL AVERAGE OF ALL EXPERIMENTS					
	Expts.	Subjects	Carbon-dioxide output per min.	Oxygen absorbed per min.	Respiratory quotient	Pulse-rate per min.	Respiration-rate per min.	Ventilation per min.
			cc.	*cc.*				*liters*
Bed respiration calorimeter	36	16	190	223	0.850	58.5	15.0	
Tension-equalizer unit			185	227	0.815	59.5	13.2	
Spirometer unit	9	6	198	233	0.850	59.5	14.1	
Tension-equalizer unit			197	231	0.855	58.5	12.8	
Zuntz-Geppert	11	6	186	227	0.82	64.5	17.0	5.96
Tension-equalizer unit			190	224	0.85	63.0	15.9	
Zuntz-Geppert	22	9	176	220	0.80	58.5	12.3	4.45
Spirometer unit			182	219	0.83	58.5	12.5	4.76
Tissot	10	2	167	194	0.86	48.0	10.2	4.26
Tension-equalizer unit			165	193	0.855	47.0	10.1	
Tissot	17	7	192	242	0.795	60.5	13.9	5.00
Spirometer unit			190	233	0.815	60.5	12.4	4.96
Douglas	16	8	178	224	0.795	62.0	15.3	5.15
Spirometer unit			189	231	0.820	61.5	14.3	5.04
Mouth-breathing / Nose-breathing — Tension-equalizer unit	9	5	187	220	0.85	55.0	13.6	
			183	219	0.835	54.5	13.2	
Mouth-breathing / Nose-breathing — Spirometer unit	5	4	190	225	0.845	64.5	14.5	4.96
			185	220	0.84	63.0	14.7	4.88
Mouth-breathing / Nose-breathing — Tissot	5	3	197	247	0.80	58.0	14.2	4.68
			191	246	0.775	57.5	15.0	4.87
Mask / Nosepieces — Spirometer unit	5	3	201	253	0.80	62.5	15.3	6.16
			206	252	0.815	63.5	14.7	5.36
Mueller valves, Tissot spirometer	5	2	194	233	0.83	58.0	17.6	6.48
Spirometer unit			187	225	0.83	57.5	20.3	5.88
Mueller valves / Tissot valves — Tissot spirometer	7	3	192	233	0.825	59.0	15.5	5.73
			188	231	0.815	57.5	20.9	5.64
As normally used / With added dead space — Spirometer unit	13	6	191	238	0.80	63.0	11.6	4.71
			197	239	0.825	64.5	11 8	6 07
Automatically counterpoised / Approximately counterpoised — Tissot spirometer	7	4	187	231	0.81	59.5	14.0	4.83
			188	229	0.82	59.0	15.1	4.91

bag); masks, rubber mouthpiece, glass and pneumatic nosepieces, Mueller valves, and Haldane gas-analysis apparatus (laboratory form and portable form).

The subjects were healthy young men, mostly medical students and laboratory assistants. The comparison of any two apparatus was made by determining the respiratory exchange of a subject with both apparatus on the same day, preferably in alternate periods. The subject was, in both tests, in the post-absorptive condition with as complete muscular repose as possible.

Measurements were made of the elimination of carbon dioxide and the absorption of oxygen from which the respiratory quotients were calculated. Records were also obtained of the average pulse-rate, the average respiration-rate, the total respiratory ventilation, and the volume per respiration. A record of the degree of muscular repose was secured by means of a special device. The accompanying table gives a general summary of the results obtained in the principal comparisons of apparatus and their modifications.

From a study of the details of the experiments, it is considered that all of the apparatus employed are suitable for the determination of the total carbon-dioxide elimination and the oxygen consumption and that the simplest and quickest method is the Benedict universal respiration apparatus. Of the apparatus with breathing appliances, the type involving the analysis of the expired air is considered the best for the determination of the respiratory quotient. The use of a rubber-lined cloth bag for collecting the expired air affords the most favorable opportunity for thoroughly mixing the portion collected, but care must be taken to select a bag which is not appreciably permeable to carbon dioxide. A spirometer for collecting the expired air is preferable to a meter, as all of the air can be collected and sampled. The Tissot valves were found to be the most reliable and efficient of the various kinds tested. In the majority of the experiments the respiratory exchange was the same irrespective of the kind of breathing appliances used. The Haldane gas-analysis apparatus is considered to be the best for the analysis of expired air but the analyses should be frequently controlled, using the constancy in composition of outdoor air as a basis.

Adequate control tests, in which such combustible materials as alcohol, ether, or other substances, whose composition is known, are advised as a means of checking the accuracy of respiration apparatus in general. A sufficient number of experiments with any given conditions and conservatism in the acceptance of results are also strongly recommended.

A detailed description of all of the apparatus used, the results of the individual experiments, and a critical discussion of the technique of determining the respiratory exchange of man in short periods are given in Publication No. 216 of the Carnegie Institution of Washington.

NEURO-MUSCULAR EFFECTS OF MODERATE DOSES OF ALCOHOL

By Raymond Dodge and Francis G. Benedict

NUTRITION LABORATORY, CARNEGIE INSTITUTION OF WASHINGTON

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In accordance with its widely distributed 'Tentative Plan'[1] the Nutrition Laboratory of the Carnegie Institution has organized and initiated an exhaustive experimental study of the physiological consequences of the ingestion of small doses of ethyl alcohol in man. The first year's work under the psychological part of that Plan was devoted to an investigation of the effects of alcohol on a selected group of interrelated processes covering the fundamental neural activities at various levels of the cerebro-spinal system, from the simplest reflexes of the lumbar cord to the most complex cortical arcs that we could accurately measure by available laboratory techniques.

The selection of the particular group of neuro-muscular processes for measurement was determined by the following experimental demands: (1) The systematic demand for coördinate data covering as many as possible of the fundamental psychophysiological operations. (2) The interpretative demand for the least possible inclusion of unknown and uncontrolled factors. (3) The practical demand for natural reaction forms which would be comparable in a large number of individuals without special practice, and would show relatively little practice effect as a result of the experimental repetition. (4) The technical demand for dependable quantitative methods of stimulation and registration.

Of the simple reflex arcs which are available for experimentation, the patellar reflex and the protective lid-reflex were chosen, chiefly because of their similar latency and the accuracy of their modern techniques. Our measurements of these reflexes include data concerning their latency, the extent of the muscle contraction, and the relative duration of the refractory phase. Of the more complex cortical arcs the following were selected: (1) eye-reactions to suddenly appearing peripheral stimuli, a thoroughly practiced phase of each individual's spatial adjustment; (2) speech reactions to visual word stimuli; and (3) free associations. The last two are characteristic phases of the individual's adjustment to his